REMARKS

Claims 1-3, 6, 7, and 9, 10, 12-25, 27, and 28 are pending, with Claims 1 and 22 being independent. Claims 5, 11, and 26 have been canceled. Claim 1 has been amended to specify that the fluorocarbon reactant is C_5F_8 and that a flow ratio of C_5F_8 to the nitrogen reactant is 3 to 7%, support for which may be found throughout the specification, for example, at page 21, lines 3-5. Claim 22 has been amended to clarify that the overlying mask layer is silicon carbide or silicon nitride. No new matter has been added.

Reconsideration and allowance of the application are respectfully requested in light of the foregoing amendments and the following remarks.

Rejection Under 35 U.S.C. § 103

- I -

Claims 1, 3, 5-7, 9-21, and 25-27 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over U.S. Patent No. 6,451,673 ("Okada") in view of U.S. Patent No. 6,090,304 ("Zhu"). The reasons for the rejection are stated on pages 2-4 of the Official Action. The rejection is respectfully traversed.

Okada is cited as teaching "using a plasma comprising at least one fluorocarbon, such as C4F8, and N2 and Ar" and "that the etchant may also include a mixture of fluorocarbons, for example C4F8 and CH2F2." (Official Action, Page 2). Zhu is cited as teaching "using more N2 than C4F8." (Official Action, Page 3).

The Official Action acknowledges that "Okada and Zhu do not teach using an etchant comprising C5F8," but asserts, "It would have been obvious to one skilled in the art to use C5F8 as the fluorocarbon etchant in place of C4F8 because Zhu

teaches using perfluorocarbons with the general formula of CnFm." (Official Action, Page 4).

Amended Claim 1 recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer comprising supporting a semiconductor substrate in a chamber of a plasma etch reactor, the semiconductor substrate having a low-k dielectric layer of a carbon-doped glass low-k material and an overlying mask layer. An oxygen-free single-fluorocarbon etching gas is supplied to the chamber and the etching gas is energized into a plasma state, the etching gas consisting essentially of at least one nitrogen reactant, C_5F_8, and optional carrier gas. A flow ratio of C_5F_8 to the nitrogen reactant is 3 to 7%. Exposed portions of the low-k dielectric layer are etched with the plasma so as to etch openings in the low-k dielectric layer with the plasma while providing a etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5. The plasma etch reactor comprises a dual frequency parallel plate plasma reactor having a showerhead electrode and a bottom electrode on which the substrate is supported.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. MPEP § 2142.

Applicants point out that specifically, Zhu discloses "a $C_xF_y/N_2/Ar$ mixture, where 'x' ranges between 1 and 4, and 'y' ranges between about 1 and 8." (Column

5, Lines 40-42). Thus, it is respectfully submitted that Okada in view of Zhu fails to disclose or suggest C_5F_8 as a fluorocarbon etchant.

The following Table summarizes the results found in Tables 1-3 on page 21-23 of the above-identified application for C_4F_8 and C_5F_8 for a flow ratio of C_xF_y/N_2 of 5%. The data shows that C_5F_8 provides substantially higher low-k dielectric etch rate with better selectivity for SiC and SiN compared to C_4F_8. As such, this data establishes that C_4F_8 and C_5F_8 are not equivalent. Rather, C_5F_8 provides unexpected improvements compared to C_4F_8.

C_xF_y	Low-k Dielectric Etch Rate (Å/min)	SiC Etch Rate (Å/min)	SiN Etch Rate (Å/min)
C_5F_8	3600	375[1]	265[2]
C_4F_8	3000	575[3]	425[4]

Accordingly, it is respectfully submitted that Okada in view of Zhu fails to disclose or suggest "a flow ratio of C_5F_8 to the nitrogen reactant is 3 to 7%," as recited in Claim 1 and the unexpected results explained above rebut any *prima facie* case of obviousness based on this combination of references.

Withdrawal of this rejection is respectfully requested.

- II -

Claims 2 stands rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Okada and Zhu in view of U.S. Patent No. 6,251,770 ("Uglow"). The reasons for the rejection are stated on page 5 of the Official Action. The rejection is respectfully traversed.

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1 C_5F_8 - Low-k Dielectric/SiC Selectivity of 9.6.
2 C_5F_8 - Low-k Dielectric/SiN Selectivity of 13.6.
3 C_4F_8 - Low-k Dielectric/SiC Selectivity of 5.2.
4 C_4F_8 - Low-k Dielectric/SiN Selectivity of 7.1.

It is respectfully submitted that Uglow, cited as teaching that underlying barrier layers are typically SiN or SiC, fails to cure the above-noted deficiencies with respect to Okada in view of Zhu.

Withdrawal of this rejection is respectfully requested.

- III -

Claims 22-24 and 28 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over U.S. Patent No. 6,506,680 ("Kim") in view of U.S. Patent No. 6,284,149 ("Li"). The reasons for the rejection are stated on pages 5-6 of the Official Action. The rejection is respectfully traversed.

According to the Official Action, "Li teaches a process similar to that of Kim's. Li teaches adding a substantial amount of N2, and Li provides example in which the flow rate of N2 far exceeds the claimed minimum amount. Li teaches exciting the etching gas into a plasma with the application of multiple RF frequencies." (Official Action at Pages 5-6).

Amended Claim 22 recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer comprising supporting a semiconductor substrate in a chamber of a plasma etch reactor, the semiconductor substrate having a low-k dielectric layer of a doped glass low-k material and an overlying mask layer of silicon carbide or silicon nitride. An oxygen-free etching gas is supplied to the chamber and the etching gas is energized into a plasma state, the etching gas consisting essentially of C_4F_8, CF_2H_2, N_2 and optionally Ar, the C_4F_8, CF_2H_2 and N_2 being supplied to the chamber at flow rates such that the total C_4F_8 and CF_2H_2 flow rate is 30% or less of the N_2 flow rate. Exposed portions of the low-k dielectric layer are etched with the plasma so as to etch openings in the low-k dielectric layer with

the plasma while providing a etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5.

Kim discloses a semiconductor device including a first dielectric layer formed on a semiconductor substrate, and a second dielectric layer formed on the first dielectric layer. (Abstract). The semiconductor device etched by the method of Kim does not include an overlying mask layer of silicon carbide or silicon nitride. Kim discloses that the second dielectric layer is etched with high selectivity to the first dielectric layer. (Column 3, Lines 56-61; Column 6, Lines 40-47).

The present application differentiates between an overlying mask layer and a photoresist layer. (see Page 8, Line 21 – Page 10, Line 15, and associated FIGs. 1-3). In particular, as disclosed in the present application, the overlying mask layer may comprise a silicon nitride film or a silicon carbide film. (Page 5, Lines 10-12).

It is respectfully submitted that the combination of Kim and Li does not disclose or suggest all the claim limitations. Specifically, the combination of Kim, which does not disclose an overlying mask layer of silicon carbide or silicon nitride and therefore does not disclose plasma etching a low-k dielectric layer with selectivity to an overlying mask layer of silicon carbide or silicon nitride, and Li, cited as disclosing adding a substantial amount of N_2 and exciting the etching gas into a plasma with the application of multiple RF frequencies, does not disclose or suggest the combination of features recited in independent Claim 22 which includes an ***overlying mask layer of silicon carbide or silicon nitride*** and a ***etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5***. Accordingly, withdrawal of this rejection is respectfully requested.

Conclusion

For at least the reasons noted above, reconsideration of the claims and allowance of the subject application is earnestly solicited. In the event that there are any questions relating to this application, it would be appreciated if the Examiner would telephone the undersigned attorney concerning such questions so that prosecution of this application may be expedited.

In the event any further fees are due to maintain pendency of this application, the Examiner is authorized to charge such fees to Deposit Account No. 02-4800.

Respectfully submitted,

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